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Prevalence of Guideline-Directed Medical Therapy for Cardiovascular Disease Among Baltimore City Adults in the Healthy Aging in Neighborhoods of Diversity Across the Life Span (HANDLS) Study

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Abstract

Objective Guideline-directed medical therapy (GDMT) has been shown to improve outcomes for people with cardiovascular disease (CVD). Our goal was to assess racial and socioeconomic differences in GDMT use among a diverse population.

Methods We examined the cross-sectional association of race and poverty status with GDMT among 441 participants with CVD in a longitudinal cohort of urban-dwelling Black and White adults in Baltimore City, Maryland, using multivariable logistic regression. CVD status and GDMT were self-reported.

Results The participants' mean age was 60.5 (SD 8.5) years, with 61.7% women, 64.4% Black, and 46.9% living below poverty. Of the 126 participants with coronary artery disease (CAD), 37.3%, 54.8%, and 62.7% were on aspirin, antiplatelets, and statins, respectively. Black participants with CAD were less likely to be on aspirin, OR 0.29 (95% CI 0.13–0.67), and on combination GDMT (antiplatelet and statin), OR 0.36 (0.16–0.78) compared to Whites. There were no differences by poverty status in GDMT for CAD. Fully, 222 participants reported atrial fibrillation (AF), but only 10.5% were on anticoagulation with no significant difference by race or poverty status. The use of GDMT for heart failure and stroke was also low overall, but there were no differences by race or poverty status.

Conclusions Among an urban-dwelling population of adults, the use of secondary prevention of CVD was low, with lower aspirin and combination GDMT for Black participants with CAD. Efforts to improve GDMT use at the patient and provider levels may be needed to improve morbidity and mortality and reduce disparities in CVD.

Keywords Cardiovascular disease · Guideline-directed medical therapy · Socioeconomic status

Cardiovascular disease (CVD) is the leading cause of death worldwide [1]. For people with established CVD, guideline-directed medical therapies (GDMT) have been shown to improve clinical outcomes. Aspirin and statins in individuals with coronary artery disease (CAD) and ischemic stroke [2, 3] anticoagulation in those with atrial fibrillation (AF) [4], and neurohormonal therapies (β blockers [BB], angiotensin converting enzyme inhibitors [ACE], aldosterone receptor blockers [ARB], mineralocorticoid receptor antagonists [MRA], and angiotensin receptor-neprilysin inhibitors [ARNI]) in people with heart failure with reduced ejection fraction (HF) have been shown to reduce recurrent events and mortality [5].

Racial disparities in cardiovascular outcomes have been documented, with a two-fold higher mortality rate in Black compared to White individuals [1]. These disparities may be in part due to socioeconomic factors [6]. Previous research showed that many eligible patients do not receive GDMT at hospital discharge or in the outpatient setting [7–12]. Most

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patients who are not prescribed GDMT at hospital discharge do not fill a prescription in the outpatient setting [13]. Furthermore, clinicians do not always initiate GDMT in stable outpatients [14]. The prevalence of the use of GDMT in CVD and whether it differs by race and/or socioeconomic status (SES) have not been explored in a contemporary diverse cohort. Understanding the distribution of GDMT among racial minorities and medically underserved individuals could lead to the identification of groups in need of targeted interventions to mitigate CVD disparities.

Our goal was to assess the prevalence of GDMT among individuals with established CVD in a socioeconomically diverse, bi-racial population of adults living in Baltimore City, and to determine whether there were differences by race and/or poverty status [15].

Methods

Study Design

This was a cross-sectional study of the association of race and poverty status with utilization of GDMT for CVD.

Setting

We drew participants from the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study, a longitudinal cohort designed to investigate the relationships of race and SES with health [15]. The cohort consisted of Black and White adults in Baltimore City. Three thousand seven hundred twenty-two individuals aged 30–64 years, from 13 pre-determined neighborhoods (groups of contiguous census tracts) reflecting an area probability sample of Baltimore City, were enrolled beginning in 2004. The study was designed to sample a range of circumstances in a 4-way factorial cross of age (seven, 5-year age groups between 30 and 64), sex, race, and SES indexed by poverty status (below or above 125% of the Federal Poverty Guidelines for 2004).

Participants

For our study, we included individuals with prevalent atherosclerotic CVD (myocardial infarction, stroke), AF, and HF by self-reporting who attended the HANDLS Wave 4 visit (between September 2013 and September 2017). We excluded individuals with missing information on the exposure, outcome, and key covariates in our primary adjustment model.

Variables

Our exposures were race (Black vs. White) and poverty status (above vs. below). Our outcome was the self-reported use of GDMT: aspirin or antiplatelets and statins for atherosclerotic CVD (yes vs. no for each); anticoagulation for AF (yes vs. no); BB, ACE or ARB, and MRA for heart failure (yes vs. no for each). Covariates included were obtained from medical history, physical examination, laboratory measures, and a detailed questionnaire collected via a medical research vehicle at the Wave 4 visit. Medical history was obtained from a household survey and included self-reported race, age, highest education level attained, self-reported hypertension, diabetes, and medical insurance status. Physical exams were performed for the measurement of systolic blood pressure (mmHg), height (meters), and weight (kg); body mass index (kg/m^2) was calculated. The diagnosis of hypertension was based upon either self-report, use of antihypertensive therapy, or measured average systolic blood pressure of ≥ 140 mmHg or diastolic blood pressure of ≥ 90 mmHg. The diagnosis of diabetes was based upon either self-report, use of anti-diabetic medications, or a measured fasting blood glucose of ≥ 126 mg/dL. Fasting blood tests were measured for hemoglobin A1c (%), estimated glomerular filtration rate (eGFR [ml/min per 1.73m^2]), and glucose (mg/dL) using a spectrophotometer (Olympus 5400; Quest Diagnostics).

Statistical Methods

Baseline characteristics were stratified by race and poverty status. We used Student's *t* tests and Pearson chi-squared tests to compare continuous and categorical variables, respectively.

GDMT for CAD and stroke was considered to include aspirin or an antiplatelet, and statins, and was modeled individually or as a composite GDMT score (0 = neither aspirin/antiplatelet nor statin, 1 = either aspirin/antiplatelet or statin, 2 = aspirin/antiplatelet and statin). GDMT for CHF was considered to include BB, ACE/ARB, and MRA and was modeled individually or as a composite score (0 = no GDMT therapies, 1 = any one of the GDMT therapies, 2 = any 2 of the GDMT therapies, 3 = all 3 of GDMT therapies). GDMT for AF was considered to include warfarin, apixaban, or rivaroxaban and was also modeled as any anticoagulation.

Age and BMI were modeled as continuous variables. Education was modeled as a categorical variable (< high school; high school or equivalent; college or greater). Chronic kidney disease was defined as eGFR < 60 ml/min per 1.73 m^2. Self-reported medical insurance status was modeled as a binary variable.

We performed multivariable logistic regression analyses for the association of race and poverty status with each component of GDMT individually and as a composite score for each of the CVD subtypes. We then adjusted for potential

confounders including age, sex, race, and poverty status (model 1). Race and poverty status were included as covariates if they were not the primary exposure for the model. Additionally, we adjusted for insurance status, body mass index (kg/m^2), diabetes, hypertension, and eGFR (model 2).

All participants signed written informed consent. The National Institute of Environmental Health Sciences, National Institutes of Health, approved the study protocol. The HANDLS study was conducted in accordance with ethical principles set forth in the Declaration of Helsinki and requirements by the US code of Federal Regulation applicable to clinical studies. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to prepare the manuscript [16]. Data analysis was performed using Stata 15.1 (Stata Corp, College Station, Texas).

Results

A total of 2171 participants completed the HANDLS Wave 4 evaluation, and after excluding 1730 participants without CVD, our final study population was 441 (Supplemental Figure 1). The participants' mean age was 60.5 years (SD 8.5), 61.7% were women, 64.4% were Black, and 46.9% had income below poverty.

A total of 126 (28.6 %) participants had CAD. Black individuals with CAD were more likely to use alcohol, have higher SBP, and have higher HDL-C (Table 1). Only 37.3% of participants with CAD were on aspirin, 54.8% were on antiplatelets (aspirin or another antiplatelet therapy), and 62.7% were on statins. Black participants with CAD had lower odds of being on aspirin compared to White participants [odds ratio (OR) 0.29 (95% CI 0.13–0.67)] in the fully adjusted model (Table 2). Participants with CAD who had incomes below poverty had higher use of antiplatelets and lower use of statins, but this did not reach statistical significance. When we examined the composite GDMT score, the log odds of being on GDMT for CAD was lower in Black participants (OR 0.36 [95% CI 0.16–0.78)]).

A total of 229 (51.9%) participants reported a history of AF. Black participants with AF were more likely to have higher SBP, higher eGFR, and higher HDL-C (Table 1). The prevalence of anticoagulation use was 10.5%. There were no significant differences in the use of warfarin, apixaban, or rivaroxaban by race or poverty status (Table 2). When we examined the composite GDMT for any anticoagulation, there was also no significant difference by race or poverty status.

A total of 102 (23.1%) participants had a history of HF. White participants with HF were more likely to have < high school education, and lower HDL-C, as compared to Black participants (Table 1). Fully, 69.6% of participants with HF were on a BB, and 57.8% were on ACEIs or ARBs. However, only 10.8% were on an MRA. There were no significant differences in the odds of individual or composite GDMT for HF by race or poverty status (Table 2).

A total of 102 (23.1%) participants reported a history of stroke. There were no significant differences in participant characteristics by race (Table 1). The use of statins, aspirin, and antiplatelets was all low in this population, at 44.1%, 15.7%, and 25.5%, respectively. There were no significant differences in the odds of individual therapies or composite GDMT for secondary prevention of stroke by race, and or poverty status (Table 2).

Discussion

In a sample of adults living in Baltimore City, the self-reported use of evidence-based secondary prevention GDMT was low, with only about one-third of the participants with CAD being on aspirin, one-tenth of those with atrial fibrillation being on anticoagulation, and less than half of participants with a history of stroke being on antiplatelet therapy and statins. Among individuals with heart failure, the majority reported taking BB and ACE/ARB; however, the use of MRA was low. Black participants with CAD were less likely to be on aspirin and combination GDMT compared to White participants. These differences were not explained by guidelines, as they recommend uniform use of GDMT regardless of patient race. Contrary to our expectations, there were no differences in the use of GDMT for CVD by poverty status.

The prevalence of aspirin and statin use among survivors of myocardial infarction in the US is 28% and 72%, respectively, based upon the National Health and Nutrition Examination Survey data [17], while nationwide, only 47% of individuals with prior stroke are on statins [18]. These estimates are similar to our findings. Furthermore, our study was unique because, despite adjusting for demographic and clinical characteristics, we found that Black individuals with CAD had 71% lower odds of taking aspirin. The suboptimal use of aspirin and statins in this urban cohort is concerning because unlike many rural areas, urban-dwelling individuals often have more access to medical care by proximity. The benefits of aspirin and statins in reducing recurrent events in people with prior myocardial infarction have been well established when no contraindications are present [19]. Aspirin is a cornerstone for secondary prevention therapies and is associated with a 22% reduction in subsequent vascular events [20]. Similarly statins have been shown to reduce the risk of recurrent events by 25% [21]. That only 37% of individuals with CAD and that there were racial differences in aspirin use, is a troubling finding and underscores the gap in implementation of evidence-based therapies.

The benefits of anticoagulation among individuals with atrial fibrillation to prevent stroke in the absence of

Table 1 Baseline characteristics by race and CVD subtype, the HANDLS study

Characteristic	Overall	CAD		*p* value	Atrial fibrillation		*p* value	CHF		*p* value	Stroke		*p* value
		Whites	Blacks		Whites	Blacks		Whites	Blacks		Whites	Blacks	
No.	441	55	71		92	137		30	72		26	76	
Age, mean (SD)	60.5 (8.5)	61.3 (8.0)	62.3 (7.9)	0.50	61.1 (8.6)	59.6 (9.2)	0.21	63.8 (6.6)	61.1 (8.1)	0.10	62.2 (8.6)	60.1 (8.1)	0.27
Female	272 (61.7%)	28 (51%)	37 (52%)	1.00	61 (66.3%)	84 (61.3%)	0.49	20 (67%)	55 (76%)	0.33	15 (58%)	49 (64%)	0.64
Poverty status	207 (46.9%)	24 (44%)	33 (46%)	0.86	33 (35.9%)	65 (47.4%)	0.10	14 (47%)	43 (60%)	0.28	15 (58%)	40 (53%)	0.82
Education													
<High School	158 (35.8%)	23 (42%)	19 (27%)	0.19	31 (33.7%)	44 (32.1%)	0.57	15 (50%)	23 (32%)	0.031	10 (38%)	33 (43%)	0.88
High school or Equivalent	143 (32.4%)	15 (27%)	27 (38%)		25 (27.2%)	46 (33.6%)		6 (20%)	34 (47%)		9 (35%)	26 (34%)	
College or higher	140 (31.7%)	17 (31%)	25 (35%)		36 (39.1%)	47 (34.3%)		9 (30%)	15 (21%)		7 (27%)	17 (22%)	
Cigarette status													
Never tried	45 (11.4%)	5 (10%)	7 (11%)	0.29	12 (15.0%)	17 (14.0%)	0.082	3 (10%)	4 (7%)	0.90	3 (13%)	3 (4%)	0.40
Tried, never used regularly	31 (7.8%)	2 (4%)	4 (6%)		6 (7.5%)	13 (10.7%)		2 (7%)	3 (5%)		0 (0%)	3 (4%)	
Former user	136 (34.4%)	15 (31%)	29 (45%)		35 (43.8%)	33 (27.3%)		11 (38%)	21 (36%)		8 (33%)	30 (42%)	
Current user	183 (46.3%)	27 (55%)	24 (38%)		27 (33.8%)	58 (47.9%)		13 (45%)	30 (52%)		13 (54%)	36 (50%)	
Alcohol use													
Never tried	18 (4.6%)	3 (7%)	5 (8%)	0.02	3 (3.8%)	5 (4.1%)	0.17	0 (0%)	4 (7%)	0.83	1 (5%)	3 (4%)	0.27
Tried, never used regularly	26 (6.6%)	6 (13%)	2 (3%)		10 (12.7%)	5 (4.1%)		3 (12%)	5 (8%)		2 (9%)	2 (3%)	
Used > 6 months ago	170 (43.5%)	25 (54%)	23 (37%)		32 (40.5%)	51 (42.1%)		17 (65%)	26 (43%)		12 (55%)	29 (43%)	
Used in past 6 months	177 (45.3%)	12 (26%)	32 (52%)		34 (43.0%)	60 (49.6%)		6 (23%)	25 (42%)		7 (32%)	34 (50%)	
Health insurance	80 (18.9%)	9 (16%)	14 (21%)	0.64	10 (11.2%)	28 (21.2%)	0.069	3 (10%)	12 (17%)	0.54	2 (8%)	13 (18%)	0.34
BMI kg/m^2, mean (SD)	31.9 (8.9)	31.5 (7.4)	31.1 (8.4)	0.82	33.1 (8.9)	30.9 (8.4)	0.061	35.3 (10.6)	34.1 (11.0)	0.62	29.2 (7.5)	31.5 (9.3)	0.28
SBP, mean (SD)	119.1 (27.4)	112.2 (31.8)	123.3 (29.9)	0.046	113.5 (25.3)	123.1 (22.8)	0.003	117.0 (30.2)	121.2 (36.8)	0.58	120.5 (20.1)	127.5 (26.6)	0.22
eGFR, mean (SD)	79.5 (25.7)	73.6 (18.8)	77.6 (27.8)	0.37	76.9 (21.2)	84.9 (25.6)	0.016	64.1 (23.1)	64.7 (34.6)	0.94	77.2 (21.4)	81.5 (24.3)	0.44
HDL mg/dL, mean (SD)	55.2 (19.6)	46.3 (12.1)	53.8 (17.0)	0.008	49.6 (16.1)	60.4 (23.1)	<0.001	45.5 (12.2)	58.5 (20.8)	0.002	47.8 (13.2)	56.2 (19.8)	0.052
HbA1c %, mean (SD)	6.5 (1.6)	7.1 (2.1)	6.7 (1.5)	0.21	6.3 (1.4)	6.5 (1.5)	0.48	7.1 (1.6)	6.5 (1.5)	0.085	6.7 (1.6)	6.4 (1.6)	0.49
Hypertension	360 (81.6%)	47 (85%)	65 (92%)	0.39	70 (76.1%)	110 (80.3%)	0.069	28 (93%)	69 (96%)	0.63	17 (65%)	62 (82%)	0.11
Diabetes	164 (37.2%)	23 (42%)	35 (49%)	0.47	29 (31.5%)	48 (35.0%)	0.061	18 (60%)	35 (49%)	0.38	10 (38%)	28 (37%)	1.00
CKD	73 (16.6%)	8 (15%)	17 (24%)	0.26	13 (14.1%)	18 (13.1%)	0.069	5 (17%)	25 (35%)	0.095	3 (12%)	11 (14%)	1.00
CAD	126 (28.6%)	55 (100%)	71 (100%)		13 (14.1%)	18 (13.1%)	0.061	8 (27%)	18 (25%)	1.00	3 (12%)	10 (13%)	1.00
Stroke	102 (23.1%)	3 (5%)	10 (14%)	0.11	9 (9.8%)	20 (14.6%)	0.069	5 (17%)	10 (14%)	0.76	26 (100%)	76 (100%)	
AF	229 (51.9%)	13 (24%)	18 (25%)	0.82	92 (100.0%)	137 (100.0%)		15 (50%)	16 (22%)	0.009	9 (35%)	20 (26%)	0.46
CHF	102 (23.1%)	8 (15%)	18 (25%)	0.14	15 (16.3%)	16 (11.7%)	0.33	30 (100%)	72 (100%)		5 (19%)	10 (13%)	0.52
Aspirin	104 (23.6%)	28 (51%)	19 (27%)	0.005	27 (29.3%)	20 (14.6%)	0.008	16 (53%)	16 (22%)	0.004	5 (19%)	11 (14%)	0.55
MRA	18 (4.1%)	2 (4%)	2 (3%)	0.79	3 (3.3%)	8 (5.8%)	0.53	3 (10%)	8 (11%)	1.00	0 (0%)	3 (4%)	0.57
ARB	66 (15.0%)	5 (9%)	13 (18%)	0.14	18 (19.6%)	25 (18.2%)	0.86	8 (27%)	9 (13%)	0.090	5 (19%)	11 (14%)	0.55
ACEI	138 (31.3%)	18 (33%)	29 (41%)	0.35	21 (22.8%)	41 (29.9%)	0.29	12 (40%)	30 (42%)	1.00	10 (38%)	22 (29%)	0.46
Beta blocker	190 (43.1%)	32 (58%)	44 (62%)	0.67	33 (35.9%)	56 (40.9%)	0.49	18 (60%)	53 (74%)	0.24	7 (27%)	24 (32%)	0.81
Anticoagulation	33 (7.5%)	8 (15%)	8 (11%)	0.58	12 (13.0%)	12 (8.8%)	0.38	3 (10%)	6 (8%)	0.72	2 (8%)	4 (5%)	0.64
Statin	196 (44.4%)	38 (69%)	41 (58%)	0.19	43 (46.7%)	42 (30.7%)	0.018	19 (63%)	33 (46%)	0.13	15 (58%)	30 (39%)	0.12
Any antiplatelets	135 (30.6%)	33 (60%)	36 (51%)	0.30	28 (30.4%)	30 (21.9%)	0.16	17 (57%)	22 (31%)	0.024	7 (27%)	19 (25%)	1.00

Legend: Baseline characteristics stratified by race. Abbreviations: *SD* standard deviation, *HDL* high-density lipoprotein, *ACE* inhibitor angiotensin converting enzyme inhibitor, *GFR* glomerular filtration rate, *CKD* defined as estimated GFR < 60 ml/min/1.73^2

Table 2 Guideline directed medical therapy for specific cardiovascular diseases, by race and poverty status.

Coronary artery disease								
	Aspirin		*Anti-Platelets*		*Statin*		*GDMT*	
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Black v. White	*0.34***[*0.16,0.72*]	*0.29***[*0.13,0.67*]	*0.63*[*0.30,1.31*]	*0.58*[*0.26,1.33*]	*0.60*[*0.28,1.28*]	*0.47*[*0.20,1.13*]	*0.44**[*0.22,0.90*]	*0.36**[*0.16,0.78*]
Below v. Above Poverty	1.08[0.50,2.32]	1.30[0.57,2.94]	1.52[0.72,3.19]	1.99[0.88,4.50]	0.54[0.25,1.15]	0.51[0.22,1.17]	0.83[0.41,1.66]	0.95[0.45,1.99]
No.	*126*	*116*	*126*	*116*	*126*	*116*	126	116
Congestive heart failure								
	ACE or ARB		*MRA*		*Beta Blocker*		*GDMT*	
Black v. White	0.73[0.30,1.80]	0.68[0.24,1.92]	0.93[0.22,3.99]	0.98[0.19,5.07]	1.75[0.69,4.42]	1.39[0.48,4.09]	1.28[0.43,3.84]	0.84[0.22,3.16]
Below v. Above Poverty	0.62[0.27,1.43]	0.62[0.24,1.58]	4.11[0.79,21.38]	4.52[0.72,28.56]	1.83[0.75,4.50]	1.86[0.68,5.13]	2.25[0.78,6.54]	1.45[0.43,4.95]
No.	*102*	*88*	*102*	*88*	*102*	*88*	102	89
Atrial Fibrillation								
	Warfarin		*Apixaban*		*Rivaroxaban*		*GDMT*	
Black v. White	1.14[0.39,3.29]	0.63[0.19,2.08]	0.33[0.03,3.76]	0.05[0.001,2.54]	0.17[0.02,1.61]	0.16[0.02,1.57]	0.65[0.28,1.53]	0.39[0.15,1.04]
Below Poverty v. Above Poverty	1.48[0.52,4.18]	2.25[0.73,6.93]	2.84[0.25,33.01]	19.07[0.41,894.6]	0.39[0.04,3.66]	0.41[0.04,4.09]	1.27[0.53,3.03]	1.84[0.72,4.73]
No.	*229*	*182*	*145*	*115*	*229*	*159*	229	182
Stroke								
	Aspirin		*Anti-Platelets*		*Statin*		*GDMT*	
Black v. White	0.72[0.22,2.36]	1.41[0.25,7.86]	0.96[0.34,2.75]	1.34[0.33,5.41]	0.50[0.20,1.27]	0.43[0.14,1.34]	0.69[0.29,1.68]	0.77[0.27,2.20]
Below Poverty v. Above Poverty	0.61[0.20,1.82]	0.37[0.09,1.53]	1.01[0.40,2.54]	0.75[0.23,2.41]	0.82[0.37,1.85]	0.96[0.38,2.42]	0.95[0.44,2.06]	0.91[0.37,2.24]
No.	*102*	*86*	*102*	*86*	*102*	*86*	102	86

Model 1 is adjusted for age, sex, poverty status

Model 2 is additionally adjusted for insurance status, body mass index, diabetes, hypertension, estimated glomerular filtration rate

Exponentiated coefficients; 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

GDMT for CAD and Stroke includes aspirin or antiplatelets and statin

GDMT for HF includes BB, MRA, ACE or ARB

GDMT for AF includes any combination of warfarin, apixaban or rivaroxaban

contraindications have been clearly demonstrated, with a 33% lower stroke risk with anticoagulation [22]. Anticoagulation is recommended in the majority of older adults with AF who have at least one CVD comorbidity based on a clinical risk score [23]. In a large US registry of patients with AF, over 80% were on anticoagulation [24], and in a study of Medicare beneficiaries with an indication for anticoagulation, 53% were prescribed anticoagulation [25]. However, in our study of adults in a "real-world" setting, the prevalence of individuals on anticoagulation was much lower at 10.5%. A recently published large registry study also showed racial differences in anticoagulation, and while our results were in the same direction, they were not statistically significant [24]. Anticoagulation is associated with bleeding risk, but in carefully selected patients, the benefits of anticoagulation in stroke prevention outweighs the risk of bleeding.

We found that the use of neurohormonal blocking medications for patients with HF were lower than those reported in national registries for ACE/ARB and BB but similar for MRA [26], with modest proportions reporting using ACE/ARB (57.8%) and BB (69.6%) and low use of MRA (10.8%). We were unable to further characterize the HF population by left ventricular function, which would be an important focus for future studies.

Our findings should be interpreted in the context of several limitations including (1) the cross-sectional design which limited our ability to attribute causation; (2) self-reported medications and disease status may have resulted in a bias by indication; (3) likely residual confounding of the association of race, SES, and GDMT; (4) lack of complete data on left ventricular ejection fraction to ascertain whether participants had heart failure with reduced vs. preserved ejection fraction; (5) lack of a measure of medication adherence; (6) potential survival bias given that individuals who survived to HANDLS wave 4 may have been those who were more adherent to GDMT; and (7) a small sample size which may have resulted in a lack of power to detect statistically significant associations. Nonetheless, our study had several strengths, including being a well-characterized, diverse cohort by age, race, and poverty status, and with measures captured in a contemporary time period likely to reflect recent prescribing patterns.

The mechanisms between race/poverty status and GDMT use are complex and our findings have implications at the provider and individual level. Education of providers about current clinical practice guidelines and incentivizing providers for adhering to guidelines may improve prescription of GDMT and promote consistency and equity in care by race and SES. At the individual level, factors such as patient-provider communication, health literacy, and knowledge of disease self-care may play a large role in lack of GDMT especially in individuals with low SES [27]. Efforts towards measuring and improving medication adherence through education, patient engagement, and cognitive-behavioral intervention are desperately needed as lack of adherence hinders effective treatment of various CVD conditions. Furthermore, reducing barriers to access to specialty care (e.g., cardiology) may result in higher GDMT use among those with CVD.

In conclusion, among a sample of adults in Baltimore City, the self-reported use of evidence-based secondary prevention medications was low, with only 37% of participants with CAD being on aspirin, 11% with AF being on anticoagulation, and less than 50% of participants with a history of stroke being on antiplatelet therapy and statins. Among individuals with HF, nearly 70% were taking BB; however, the use of ACE/ARB and MRA were 58% and 11%, respectively. Black participants with CAD were less likely to be on aspirin and combination GDMT, but there were no other significant differences in the use of GDMT by race or poverty status. Our findings were robust to adjustment for multiple sociodemographic and clinical factors. Significant gaps exist in secondary prevention and efforts targeted at both the patient and provider levels could substantially improve morbidity and mortality from CVD.

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Data Availability The study data will not be made available to other researchers for the purposes of reproducing the results or replicating the procedure because of human subjects' restrictions.

Code Availability The code is available for replication of the results.

Declarations

Conflict of Interest The authors declare no conflicts of interest.

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the National Institutes of Health and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Bioethics Committee of the National Institute of Health.

Consent to Participate Informed consent was obtained from all participants included in the study.

Consent for Publication The authors affirm that human research participants provided informed consent for publication of all the materials. Authors are responsible for correctness of the statements provided in the manuscript.**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s40615-021-00984-y.

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